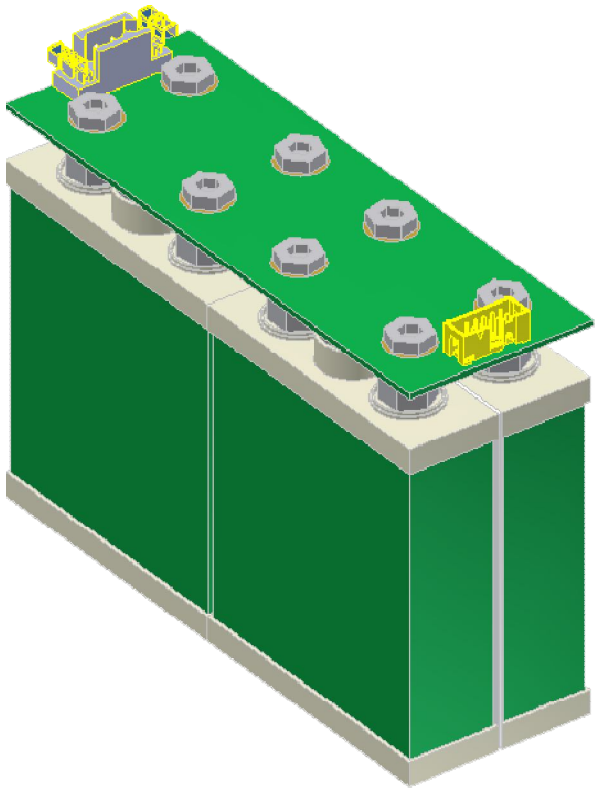
LPRDS-CMS-2011

Lafayette Photovoltaic Research and Development System

Cell Management System

ECE492 – Spring 2011



Lafayette College Electrical and Computer Engineering Department

User Manual

Draft #1

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I. Introduction

LPRDS System Overview

The Lafayette Photovoltaic Research and Development System - Cell Management System (LPRDS-CMS) is an experimental system. It uses a photovoltaic array mounted on the roof of the Acopian Engineering Center (AEC) to provide DC power for storage in a battery array and conversion to AC power by an inverter. The system is housed in AEC room 410. A row of outlets in room AEC 400 provides power from the inverter using battery storage or a combination of PV power and batteries depending on the amount of energy required by the load. The system can be monitored and controlled by the SCADA Interface Box (SIB). The system also contains a safety loop which can open relays in the Raw Power Interface (RPI) and Switch Controller (SC) in the event of a system fault. DC power is converted into 120V, 60Hz AC power through the Filter & Inverter Box (FIB). The Energy Storage System (ESS) is used to regulate the charging and discharging of the LiFePO4 batteries used in the CMS.

Cell Management System (CMS)

The main function of the CMS is to balance the state of charge of the cells used in the ESS. The CMS is capable of standalone use, but is also designed to be easily integrated into the current ESS. Under standalone conditions, packs of 4 cells each are able to be charged or discharged. On each pack of four cells is a single PCB, which is referred to as the OBPP (One Board Per Pack). These components make up the CMS. During charge cycles, the CMS attempts to balance the State of Charge (SOC) of the four cells in a pack in order to increase the lifetime and efficiency of the battery pack.

The CMS can also operate as a part of the LPRDS-ESS. In this setting, the CMS becomes a slave to the ESS Controller Board (ESSCB). The charging and discharging of the pack are then controlled by the LPRDS-SCADA system. In this mode, the CMS can also be used to monitor each of the cell voltages, currents, and temperatures. This setting also allows the monitoring of the State of Charge of the ESS stack.

Each BMS includes a display that shows whether the pack is being charged or discharged, whether the pack is fully charged or fully discharged, and also whether the pack is running in standalone mode, or if it is running as a part of the ESS.

II. Getting Started

System Components

A. Batteries- The LPRDS-ESS system requires that Li-ion batteries be used. Specifically, the batteries must be Lithium Iron Phosphate (LiFePO4) cells, with a capacity of 3.2V, C = 10Ah, and must measure 82x27x108 mm (LxWxH). Batteries must be connected in packs of 4 cells, as shown below in *figure 1.*

B. One Board Per Pack (OBPP)- The OBPP is the board responsible for managing and monitoring each cell in a pack of four cells. This board must be mounted in the appropriate orientation onto a pack of four cells.

C. Bolts, and Spacers- Provided with each OBPP are 8 Aluminum spacers and 8 bolts to secure the board to a pack of 4 cells.

D. Connectors – TBD. Connectors will be necessary for both connecting power to packs in series, and for connecting to the I2C communication interface.

E. On Board Display- The LED display on the OBPP is an important component that provides basic details about the status of the BMS. See figure x below for more details.

Extras You May Need

A. Constant Current Power Supply- For cell charging, it is recommended to use a constant current source. The current source should be limited to no more than 2C (20A).

B. Constant Current Load- For cell discharging, it is recommended to use a constant current load, such as a resistor or a linear current regulator.

C. Relay- It may be convenient to use a relay when charging a pack. A common emitter output on the OBPP provides a logic high output during the pack's charge cycle, and a logic low when the pack is fully charged. Connecting the power supply to the pack through a relay controlled by this output will prevent the pack from being over charged.

D. Safety Glasses- Please, be cautious when working with high voltage electronics. Particularly when connecting several packs in series, it is important to wear safety glasses.

III. Installation

Standalone Operation

Install OBPP on pack of 4 cells

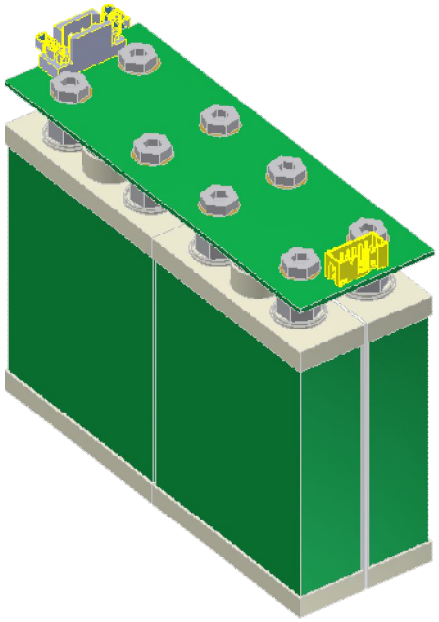
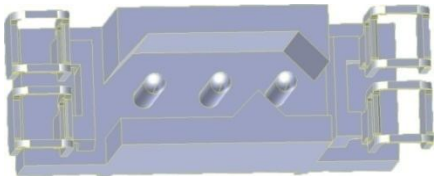


Figure 1

1.) Secure four cells in place in the formation shown in *figure 1*
2.) Using 2 inch Aluminum spacers between the cell terminals and the holes on the OBPP, place the board onto the pack so that the holes and the terminals are lined up. Screw the provided bolts into each hole to secure the board in place.
3.) If connecting more than one pack, connect current source to each pack via the connector as shown below in *figure 2*.



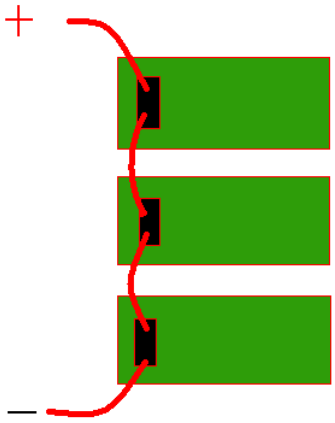


Figure 2

Integration with ESS

Install OBPP on pack of 4 cells

1.) Secure four cells in place in the formation shown in *figure 1.*
2.) Using 2 inch Aluminum spacers between the cell terminals and the holes on the OBPP, place the board onto the pack so that the holes and the terminals are lined up. Screw the provided nuts into each hole to secure the board in place.
3.) Connect the power and communications cables as shown in *figure 3*

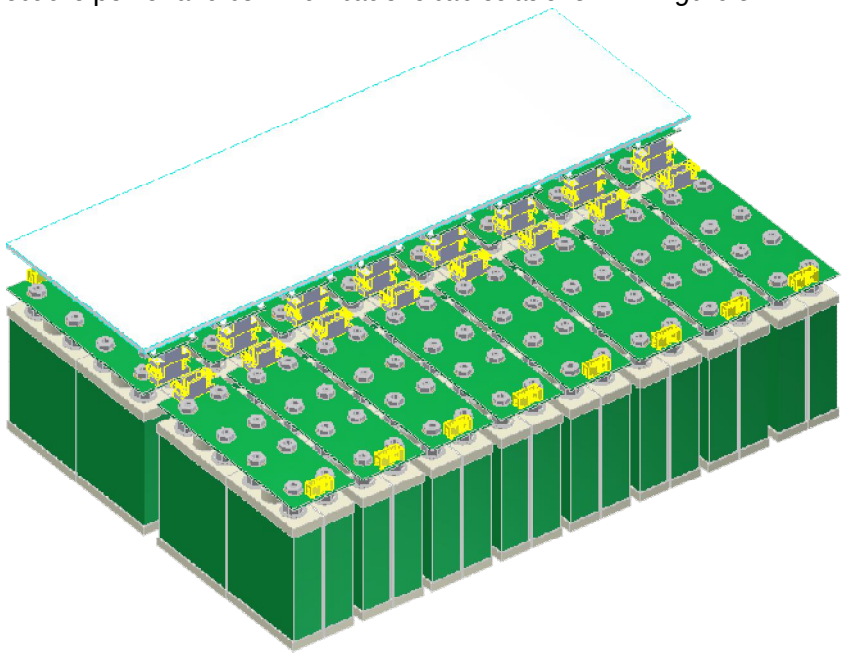


Figure 3

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4.) Turn on LPRDS. See LPRDS-2010 User Manual for further instructions.
5.) Press the "Reset" button on the OBPP. Charging or discharging should begin automatically. Observe the LED's on the OBPP to see the status of the system. The orange light should be solid to signify that the pack is connected to the ESS. The LED on the front panel of the ESS will display the current State of Charge of the stack.

IV. Operating Instructions

Charge a Pack

1.) After setting up the system as shown above, connect the ground terminal of a constant current power supply to the unconnected ground terminal of the set of packs. Do not yet turn on the power supply.
2.) Between the positive terminal of the power supply and the unconnected positive terminal of the pack, insert a relay. Connect the controls of the relay to the positive and ground terminals on the OBPP where it is labeled “Relay”.
3.) Press the “Reset” button on the OBPP.
4.) Turn the power supply on. You should see the green LED on the OBPP blinking or solid. If the light is solid green, then at least one cell in the pack is fully charged and cannot be charged anymore. If the light is blinking, then the cell is properly charging. If the green light is not on at all, something is likely wrong. Try disconnecting the power supply, pressing the reset button, and starting over.

Discharge a Pack

1.) After setting up the system as shown above, connect the ground terminal of a constant current source or resistor (not a power supply) to the unconnected positive terminal of the set of packs.
2.) Between the positive terminal of the current supply or resistor and the unconnected positive terminal of the pack, insert a relay. Connect the controls of the relay to the positive and ground terminals on the OBPP where it is labeled “Relay”.
3.) Press the “Reset” button on the OBPP.
4.) You should see the red LED on the OBPP blinking or solid. If the light is solid red, then at least one cell in the pack is fully discharged and cannot be discharged anymore. If the light is blinking, then the cell is properly discharging. If the red light is not on at all, something is likely wrong. Try disconnecting the load, pressing the reset button, and starting over.